

Effects of Temperature and Pressure on CO₂ absorption and Changes in Coal due to CO₂ Sequestration and CH₄ Desorption

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Introduction.

The objective of this write up is to explain how coals change with varying amount of carbon dioxide and methane in it. This is necessary because coal-bed is a good option for storage of carbon dioxide in order to mitigate adverse effects of too much CO₂ in the atmosphere.

Permeability of Coal

Permeability of coal may reduce as a result of pressure reduction due to loss of water during CH₄ production. The cleats tend to close up as a result of decrease in pore pressure due to water loss. However as more methane is lost or desorbed, the coal matrix tends to shrink thereby increasing permeability of the coal. Coalbeds suitable for CO₂ sequestration should therefore have high initial permeability and dense cleat spacing. Permeability of deep (>1000 m; >3300 ft) coal formations is usually low. [1]. Deep coal formations should be excellent candidates for CO₂ sequestration in terms of leakages. Leakage of CO₂ in deeper coals to the atmosphere would be minimal when compared to coal seams that are close to the surface. Deeper coalbeds are usually of higher ranks than near-surface coalbeds. As a result of more compaction of deeper coalbeds, they tend to have lower porosity and lower permeability when compared to near-surface low rank coals. The relationships between cleats and random vitrinite reflectance of coals are expressed by the equations below. [2]

$$Cf = 0.473 e^{0.917/Ro}$$

where

Cf = mean face cleat spacing, cm

Ro = % mean random vitrinite reflectance

$$\text{and } Cb = 0.568 e^{1.065/Ro}$$

where Cb = mean face cleat spacing

Ro = % mean random vitrinite reflectance

On absorption of much CO_2 , permeability of coal formation usually decrease due to swelling of the coal matrix leading to reduction in the cleats sizes. [3]

Porosity

Porosity of coal tends to reduce as a result of swelling of coal matrix on absorption of more CO_2 relative to the amount of CH_4 desorbed. Coalbeds tend to prefer absorption of CO_2 to CH_4 . [3]. Laboratory studies of coals showed that coals can absorb between two to eighteen moles of CO_2 for every mole of CH_4 displaced. [4]

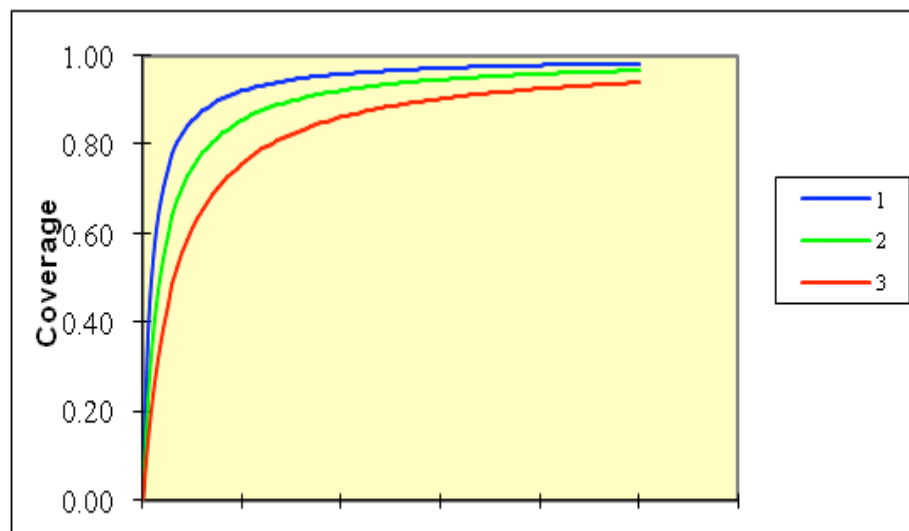
Effects of Temperature and Pressure on CO_2 storage.

Temperature increase tend to decrease coal storage capacity while pressure increase has opposite effect i.e. increase storage capacity of Coal with CO_2 . [5] The main mechanism whereby micropores of formations such as coals are filled with CH_4 and CO_2 are known as type 1 isotherms or Langmuir-type isotherm. [6]

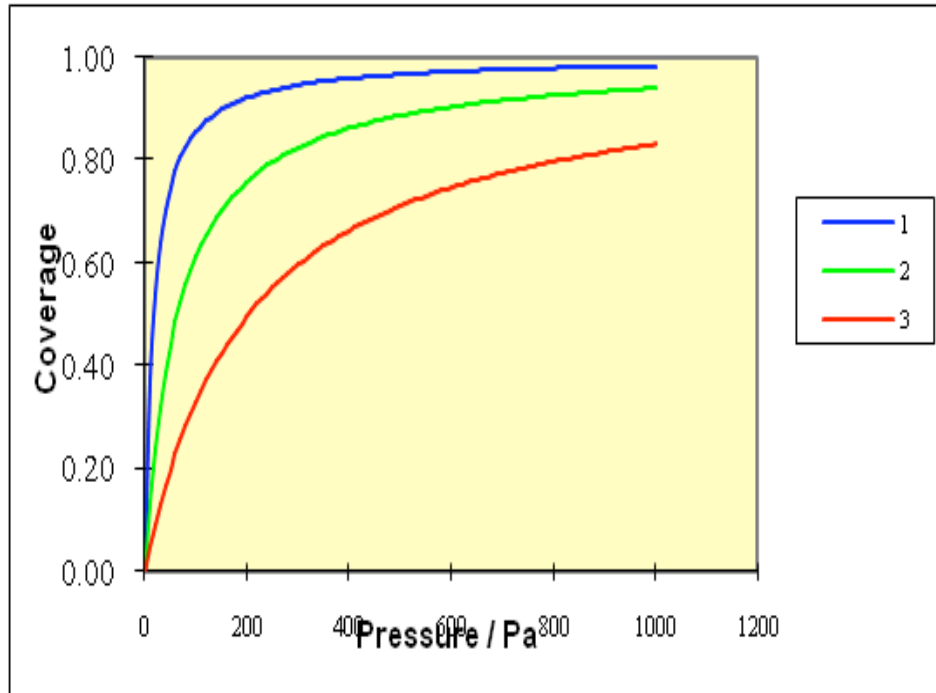
A simple modeling of CO_2 and CH_4 absorption rate with changes in pressure and temperature are shown below.

Simple Simulation of CO_2 Absorption with Changes in Pressure and Temperature.

Pressure	Pressure range from zero Pascal to 1000 Pascal		
Temperature	(1) 280K	(2) 290K	(3) 300K



Pressure	Pressure range from zero Pascal to 1000 Pascal		
Temperature	(1) 280K	(2) 300K	(3) 320K



The two above examples clearly show that the increase of pressure enhance CO₂ absorption while increase of temperature decrease CO₂ absorption. These examples are only rough estimates to show the effects of temperature and pressure on carbon dioxide absorption. [7]

Future Plans

The future project will involve establishing quantitative relationships between variation in carbon dioxide content in coals and its velocity. This will enable proper monitoring and proper prediction of CO₂ movement in coals.

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